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Diet and Dietary Habits of The *Mystus gulio* from The Cianjur Estuaries, Indonesia

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Abstract. *Food and feeding habits are important things in bioecological of fish. This study provides an understanding of the feeding habits and intensity of the M. gulio, by analyzing its food composition, relative gut length (RGL) and gastro-somatic index (GaSI). Fish specimens were caught with a gill net and fishing rod in an area of Cianjur estuaries during a period of one year from October 2021 to September 2022. The analysis of 452 fish samples shows that the relative gut length (RGL) values revealed the feeding habit of M. gulio as carni-omnivorous. The GaSI value was used to determine feeding intensity and was found to be highest in November, at Cidamar estuary, and in the second size group (7.1-10 cm). These results provide new knowledge on this fish species' feeding habit and intensity, which also helps understand the fish adaptation and conservation in the study area.*

Keywords: *estuary, food, gastro-somatic index, Mystus gulio, relative gut length*

Citation
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INTRODUCTION

Mystus gulio is a fish with economic value in several areas, such as Bangladesh (Kumar et al., 2019). *M. gulio*, with the local name "ikan keting" belongs to the catfish group, the genus of *Mystus* sp., the family of Bagridae, and the order Siluriformes (Kottelat & Whitten, 1996). Based on its habitat, this fish can be found in river estuaries and muddy substrates (Hossain et al., 2015). In Asia, this fish is distributed in Indonesia (Paujiah et al., 2019), India (Talwar & Jhingran, 1991), Vietnam (Vo et al., 2023), and Sri Lanka (Kumar et al., 2019). In Indonesia, this fish is distributed in the Sunda Shelf (Kottelat & Whitten, 1996).

The study of food and feeding habits is essential to fish biology and management (Chipps et al., 2007). Analysis of Relative gut length and Gastro-somatic index are two aspects that have long been used and are widely accepted as important descriptors of gut morphology and indicators of food composition (Lanthaimeilu & Bhattacharjee, 2018). Relative gut lengths (RGL) in vertebrates have long been studied and compared within and between species (German & Horn, 2006). The increase in relative intestinal length is related to adaptation, where one of its functions is to maximize the number of nutrients that can be digested. In addition, its other functions are to increase the time food remains in the intestine during digestion and absorption, and to increase the surface area available for absorption (Hossain & Dutta, 2017; Leigh et al., 2018). In fish, RGL helps to understand the eating habits of fish (Dinh et al., 2022). In addition to RGL analysis, GaSI (gastro somatic index) can be used to analyze the feeding intensity of fish (Chen & Liu., 2022). Generally, food intensity varies according to season, availability of preferred foods, stage of maturity, and spawning season (Le Pape & Bonhommeau, 2015; Bhakta et al, 2019). Among fish species, there is ecological and morphological diversity (Villéger et al., 2017), including the *M. gulio* that inhabits estuarine waters (Paujiah et al., 2019).

The Cianjur, West Java, Indonesia, has several large estuaries, such as Ciujung, Cipandak, and Cidamar. Based on observation, each of the estuaries has different characteristics, such as the environmental conditions around the estuary and the phenomenon of the meeting between freshwater and seawater. With unique characteristics in each estuary, it is possible to have different habitat conditions to present different preferences for the organisms in it, including the *M. gulio*.

The existence of fish populations in estuaries can be influenced by several factors, such as deforestation, urbanization, and environmental pollution (Dinh et al., 2018). In the M. gulio, no data was found regarding variations in food habits associated with RGL and GaSI, which were analyzed based on time, place, and size. These characteristics are primary data to understand how the environment influences fish activity and fish interactions within the community. Therefore, this study aimed to present new knowledge about *M. gulio* food composition, RGL, and GaSI based on time, location, and size. The results of this study can help understand fish food habitats and the adaptability of fish in muddy habitats.

MATERIALS AND METHODS

Research on food composition, RGL, and GaSI in *M. gulio* was conducted from October 2021 to September 2022 at the integrated laboratory of UIN Sunan Gunung Djati Bandung, West Java, Indonesia. Fish samples were obtained from three river estuaries in Cianjur Regency, West Java, Indonesia (Figure 1). The stages carried out in this study are as follows.

Fish Collection and Sampling

The fishing gears used for sampling were gill nets with mesh sizes of 0.75" and 1" and fishing rods. The fishing duration at each station lasts for four hours (one effort). The *M. gulio* was identified based on the identification key presented in Kottelat & Whitten (1996). The research was performed following the guidelines approved by the animal care and use committee of UIN Sunan Gunung Djati Bandung, Indonesia.

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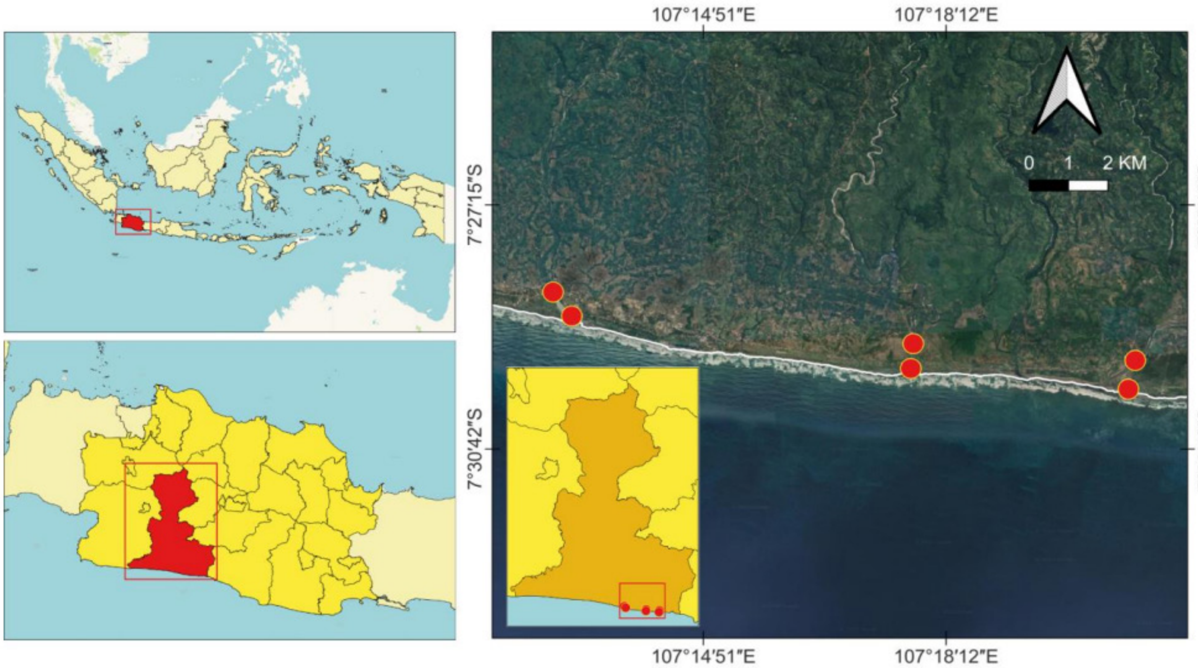


Figure 1. Study sites in Cianjur estuaries, West Java, Indonesia

Collecting Gut Specimen

The fish sample was dissected with a scissor and checked for gut fullness. After removing from the fish specimen, the digestive tract was measured to the length (Lg) of the nearest 0.1 cm and weight (Wg) of the nearest 0.01 mg to calculate the relative gut length (RGL) and gastro somatic index (GaSI) (Mingist et al., 2023).

Length and Weight Measurement

Fish specimens were measured the total length (TL) to the nearest 0.1 cm using a measuring caliper and body weight (W) to the nearest 0.01 g using an analytical digital scale (FUJITSU FS-AR). The RGL was used to determine feeding habits (Chen & Liu, 2022), e.g., carnivore (RGL1-3) (Mitu & Alam, 2016), and the GaSI was used to estimate feeding intensity (Chen & Liu, 2022).

Data Analysis

Descriptive analysis was applied to the data. All the collected data were plotted in tabular form and then represented in graphical form for better calculation and assessment.

Confirmation of Proteinaceous Character

Analysis of stomach contents was used to determine the feeding habits of fish and analyzed using the Index of Preponderance (IP) formula as follows:

Diet Composition

Analysis of stomach contents was used to determine the feeding habits of fish and analyzed using the Index of Preponderance (IP) formula as follows:

$$I_i = \frac{V_i \, x \, O_i}{\sum(V_i \, x \, O_i)} \, x \, 100 \quad (1)$$

With *Ii* = Index of Preponderance; *Oi* = volume percentage of one type of food; *O*i = percentage frequency of occurrence of one type of food; and ∑ (*Vi* x *Oi*) = total *Vi* x *Oi* of all kinds of food.

Relative Gut Length and Gastro Somatic Index

The characterization of different-sized fish as carnivores, herbivores, and omnivores used the Relative gut length (RGL) as a main morphological variable. At the same time, the Gastro-somatic index (GaSI) determined feeding intensity. The RGL of the fish was determined by the following German & Horn (2006):

$$RGL = \frac{\text{Total length of gut (Lg)}}{\text{Total length of fish (Tl)}} \quad (2)$$

While the variations in the feeding intensity of different size groups in each fish were calculated by the following formula of Samad et al. (2023):

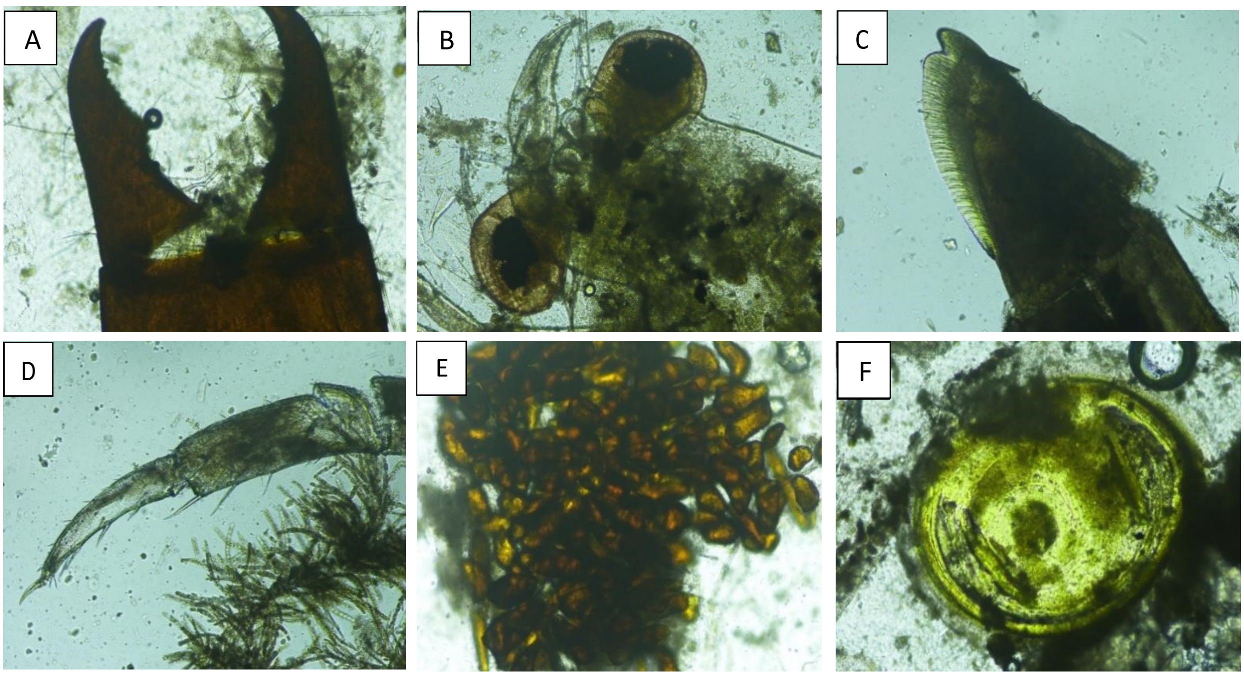
$$GaSI = \frac{\text{Wt of gut}}{\text{Wt of fish}} \times 100, \quad (3)$$

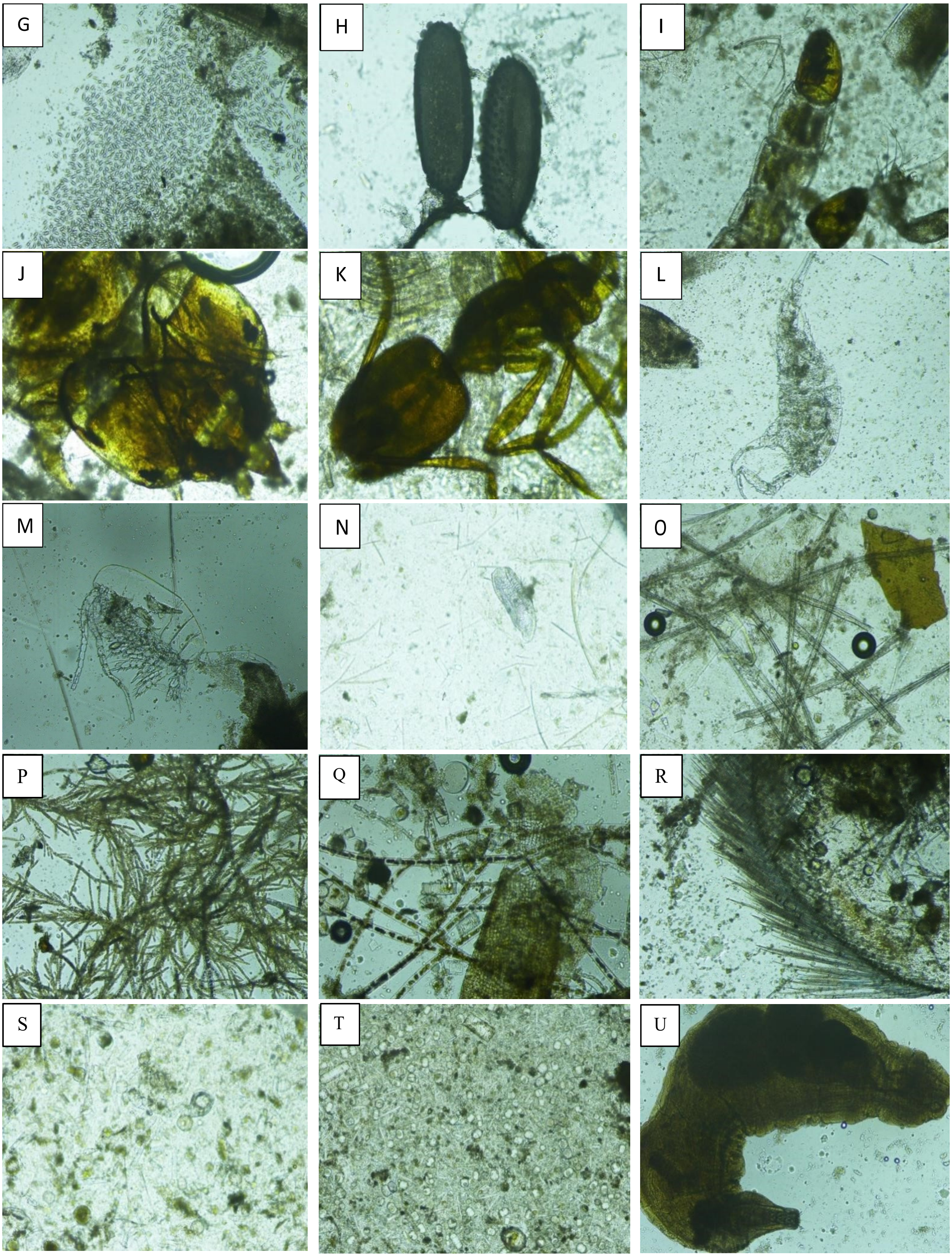
RGL and GaSI were analyzed by location, time, and size. Based on the location, three river estuary locations were used, namely the estuary of the Ciujung, Cipandak, and Cidamar. Based on the time, RGL and GaSI were analyzed every month for one year. Based on size, the fish were divided into three size groups, namely group 1 (<7 cm), group 2 (7.1-10 cm), group 3 (10.1-15 cm), and group fourth (>15 cm).

RESULTS AND DISCUSSION

Diet Composition

The results showed that the composition of the *M. gulio* food each month showed various components. The types of food observed consisted of seven main groups, namely crustaceans, insects, mollusks, fish, annelids, detritus, plants, and algae (Figure 2). The IP values based on time are presented in Table 1.

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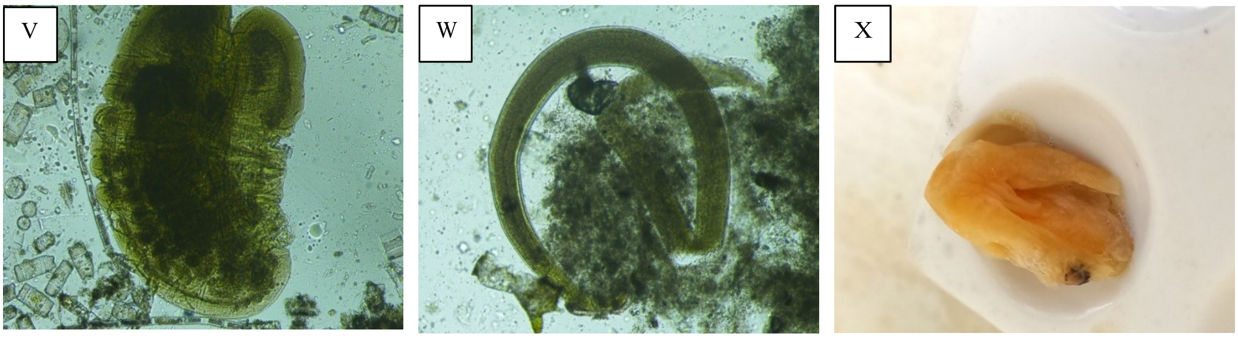

Figure 2. The digestive tract contents *M. gulio* from the estuary of the Cianjur estuaries (crustacean-A, B, C, D, X), (egg of insect-E, F, G, H), (part of insect-I, J, K), (cructacean, L, M, N), (algae-O, P, Q), (part of chicken/ feathers, R), (plankton-S, T, V), (Annelida-W), (Trematoda-U, V).

Table 1. The IP values of each food in each month.

Month-Year	Food Group							
	Algae	Crustaceans	Insects	Mollusks	Annelida	Detritus	Plants	Pisces
Oct-21	31.77	31.69	9.14	0.05	-	27.01	-	0.34
Nov-21	24.41	1.12	45.77	0.27	-	28.09	-	0.33
Des-21	31.55	0.03	41.72	0.26	-	26.26	-	0.18
Jan-22	27.50	-	42.79	0.04	-	29.66	0.01	-
Feb-22	31.76	6.40	36.86	0.01	-	24.88	-	0.10
Mar-22	56.66	4.11	21.45	0.07	-	17.71	-	-
Apr-22	75.15	-	5.84	-	-	20.95	-	-
May-22	39.60	9.67	22.98	9.28	-	18.16	-	0.31
Jun-22	53.10	0.05	22.23	0.12	-	23.78	-	0.72
Jul-22	24.39	48.50	2.51	3.97	0.27	20.37	-	-
Aug-22	40.02	-	31.33	16.91	-	11.74	-	-
Sep-22	46.67	-	41.26	0.32	0.77	10.98	-	-

Table 1 shows that among all food groups, insects, algae, and detritus are the most dominant food groups with a high composition every month. Based on the food groups found in the intestine of *M. gulio*, it shows that this fish is euryphagous (fish that eat various types of organisms). In addition, this fish is also an omnivore because of its wide food range, starting from plankton, invertebrate, and plant groups. In Figure 2, it can be seen that several types of food identified were mosquitoes, *Daphnia* sp., *Macrobrachium* sp., mosquito eggs, pieces of shrimp and insects, algae, and other types of plankton.

The food habits of the *M. gulio* indicate that the fish is insectivore, detrivore and algivore. According to the results of a study by Suryandari & Tjahjo (2013) which showed that this fish is an eater of crustaceans, gastropods, and detritus. In addition, Gupta (2014) and Rathod (2023) also found the same food composition in the digestive tract of this fish. Compared to other species in the genus of *Mystus* sp. Species of *M. gulio* dominate different food groups. For example, in the species of *Mystus tenggara*, the dominance of the food group is insects (Mitu & Alam, 2016).

Food activities of fish occur by stimulation (Lall & Tibbets, 2009; Nanjo et al, 2008) that arises due to the color and smell of food (Weliange & Amarasinghe, 2007). In addition, fish are interested in moving objects in the water. In addition, fish are interested in moving objects in the water. Richardson et al. (2018) stated that moving prey can attract fish to prey. Food habits are also influenced by food size, food color, and fish taste for these foods (Hilker & Lewis, 2010). Meanwhile, the amount of food needed by fish depends on eating habits, food abundance, food conversion value, and food condition of the fish (Vieux et al., 2018). For *Dermogenys* sp., the color of red ants gets greater attention compared to black ants with no conspicuous color. The type of food eaten by fish generally depends on the fish's preference, the size and age of the fish, the season, and their habitat. Fish eating habits include the type, quantity, and quality of food eaten by fish. The type of food that fish will eat depends on the availability of food types in nature and also the physiological adaptations of these fish, such as the length of the intestine, the nature and physiological conditions of digestion, and the shape of the teeth (Zuliani et al., 2016).

Gastro-Somatic Index (GaSI) and The Relative Gut Length

Gastro-Somatic Index (GaSI)

The range of body weight, gut weight, and the average value of the two aspects varied each month (Table 2). Based on the range of fish weight, the lowest values were found in June and November, while the highest were found in August and October. The lowest range of fish gut weight was found in December, and the highest was found in October.

GaSI values were analyzed and presented by time/month (Figure 3), location (Figure 4), and size (Figure 5). Based on the sampling time, the highest GaSI was found in November and the lowest in May. Based on location, the largest average GaSI was found from sampling at the Cidamar estuary, and the lowest was found at the Ciujung estuary. Based on the size, the largest GaSI was found in the second-size group. Figure 5 shows the average GaSI fluctuation from the first to the fourth size group After reaching a peak in the second group, the trend of average GaSI then decreases until the fourth group.

Table 2. The range of fish weight, gut-weight, average fish weight, and average gut weight

Month-Year	Range of Fish Weight (gr)		Range of Gut Weight (gr)		Average Fish Weight (gr)	Average Gut Weight (gr)
	Min	Max	Min	Max		
Okt-21	1.80	40.80	0.25	6.1	20.39	1.60
Nov-21	1.18	36.67	0.1	3.8	8.82	1.25
Des-21	1.40	31.00	0.02	2.2	8.34	0.50
Jan-22	1.40	34.40	0.06	3.1	11.95	0.66
Feb-22	1.70	26.80	0.1	12	11.18	0.78
Mar-22	2.40	20.10	0.11	1.93	7.21	0.52
Apr-22	2.38	30.70	0.08	0.98	8.18	0.28
May-22	6.30	47.90	0.1	0.72	13.17	0.33
Jun-22	1.00	34.00	0.21	3.2	14.41	1.18
Jul-22	2.04	40.66	0.07	2.87	15.07	0.54
Aug-22	3.93	55.14	0.16	3.93	16.54	1.03
Sep-22	4.66	25.54	0.08	3.42	16.07	0.94

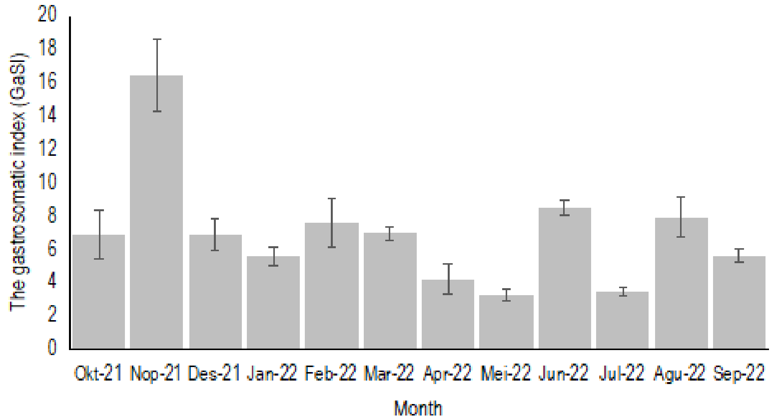

Figure 3. The variation in GaSI of *M. gulio* among 12 months; the vertical bars indicate the standard error of the mean

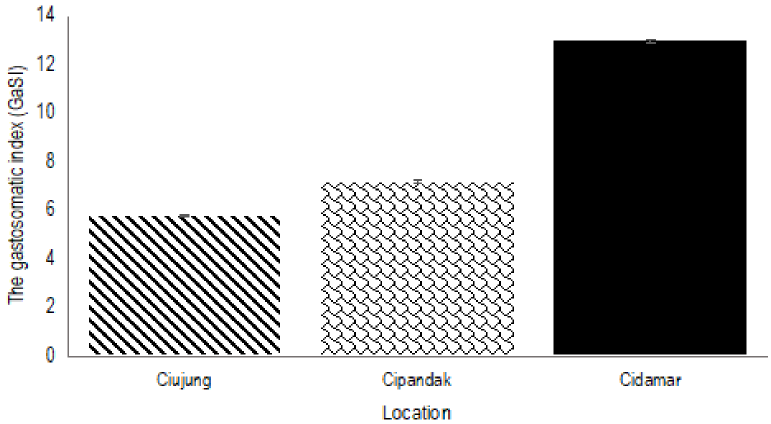

Figure 4. The variation in GaSI of *M. gulio* among three locations; the vertical bars indicate the standard error of the mean

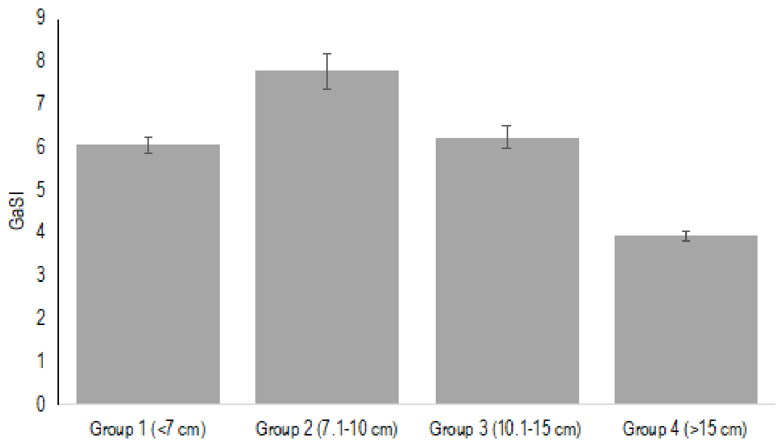

Figure 5. The variation in GaSI of *M. gulio* among four fish size groups; the vertical bars indicate the standard error of the mean;

Information about GaSI is an essential aspect of the reproductive biology of fish. In previous research, GaSI showed how much the eating intensity of a fish species (Chipps et al., 2007). The GaSI value of *M. gulio* showed a wide range of values. In the species of Mystus montanus, GaSI ranged from 0.135-21.28 (Arockraraj et al., 2004). In M. gulio, the maximum value of feeding activity was found in November, at the Cidamar estuary, and the second size group can be associated with GaSI values. Many factors can affect GaSI, Kurbah & Bhuyan (2018) stated that several factors, such as the unavailability of food, caused the decrease in the value of GaSI. In addition, other factors are abiotic factors, such as temperature and turbidity (Abbas, 2010). The content of COD and BOD in the water body can cause high turbidity, reduce the fertility of waters and affect organisms inside (Chan et al., 2013). GaSI in fish decreases during reproduction and increases before and after reproduction, representing an inverse relationship between feeding intensity and reproductive season (Kurbah & Bhuyan, 2018; Thomas et al., 2018). The results of other studies show that a low GaSI value indicates low feeding activity and is the breeding season of fish species (Sangma et al., 2019). Poor feeding during the breeding season may be due to the development of the gonads that occupy the abdominal cavity's main space (Menon, 1950). Furthermore, the availability of food in the environment and nutritional needs can also affect the feeding activity of fish (Arechavala-Lopez et al., 2022).

Relative Gut length (RGL)

Table 3 shows the body length, gut length range, and the average of the two vary each month. Based on the fish's body length range, the lowest values were found in June and November, while the highest were found in November and February, the lowest length of the fish's digestive tract was found in June, and the highest value was found in August.

Table 3. The range of fish length, gut length, average fish length, and average gut length *M. gulio*

Month-Year	Range of fish length (cm)		Range of Gut Length (cm)		Average Fish Length (cm)	Average Gut Length (cm)
	Min	Max	Min	Max		
Okt-21	7.60	16.50	4.00	17.50	12.25	12.03
Nov-21	5.00	26.50	0.95	25.80	9.68	7.49
Des-21	5.20	14.70	1.40	15.00	8.69	5.57
Jan-22	5.50	14.50	3.00	19.00	9.92	9.34
Feb-22	7.00	20.00	0.27	24.00	11.62	11.32
Mar-22	6.40	12.70	4.10	23.50	9.05	11.91
Apr-22	7.00	15.00	4.00	15.50	9.32	9.74
May-22	7.80	17.10	5.00	20.80	10.35	10.93
Jun-22	1.60	14.70	1.00	20.00	10.88	10.54
Jul-22	6.00	15.90	1.40	17.10	11.47	8.68
Aug-22	7.10	16.50	4.20	21.00	10.68	13.39
Sep-22	6.80	14.80	4.00	25.00	11.20	13.70

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RGL values were analyzed and presented by month (Figure 6), location (Figure 7), and size (Figure 8). Based on the time (month), the highest RGL was found in August, and the lowest was found in December. Based on location, the highest average RGL was found at the Cipandak estuary. Based on the size, the highest RGL was found in the first size group (<5 cm). Figure 8 shows the average RGL fluctuates from the first size group to the fourth size group. The RGL tends to increase between groups one, two, and three, then decrease in the fourth group.

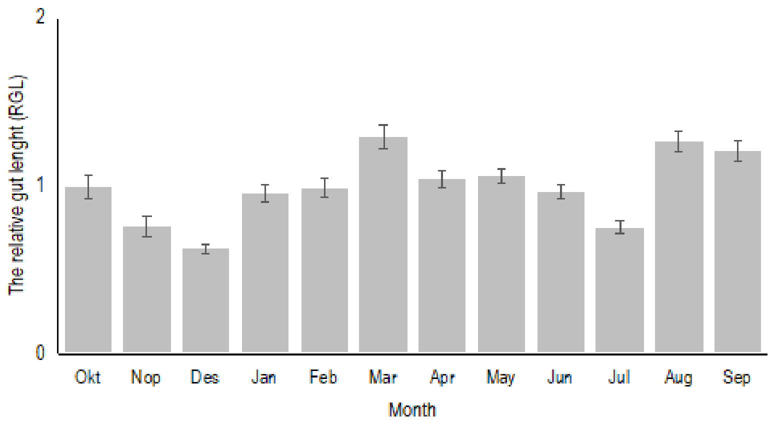

Figure 6. The variation in relative gut length of *M. gulio* among three locations; the vertical bars indicate the standard error of the mean

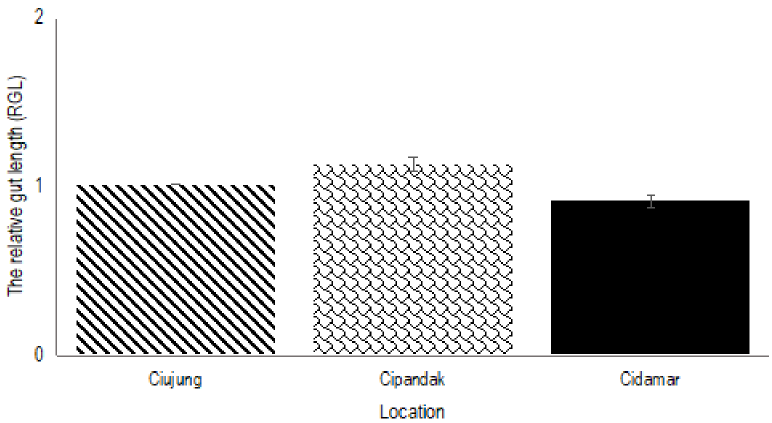

Figure 7. The variation in relative gut length of *M. gulio* among three locations; the vertical bars indicate the standard error of the mean

The feeding habits of fish can be predicted from the ratio of the gut length to the total length of the body. Moyle & Cech (2000) stated that in herbivorous fish, the digestive tract is several times longer than the body (can be up to five times the body length). In herbivorous fish, the gut length is shorter than the total body length, and the gut length in omnivore fish is only slightly longer than the total body length. The average relative gut length of *M. gulio* fish was 1 (one). Referring to the statement of German & Horn (2006) that *M. gulio* fish is carnivorous or omnivore where the relative intestinal length for carnivorous fish is 1 (one) and for omnivorous fish between 1-3. The gut contents show that the *M. gulio* fish eats crustaceans, insects, mollusks, pisces, annelids, algae, and detritus (Figure 2). So, based on the average gut relative length and the gut contents, the *M. gulio* fish is an omnivore fish that tends to be carnivorous. The RGL value in *M. gulio* has yet to be reported by other studies. Therefore, there is no comparison with the results of other researchers. However, observing the RGL values of other species in the genus *Mystus* sp,, shows that the *Mystus tenggara* has an RGL value of 0.72 (Mitu & Alam, 2016).

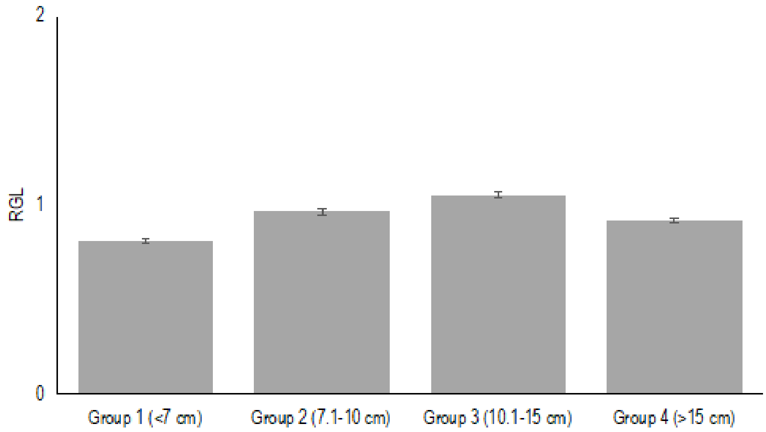

Figure 8. The variation in relative gut length of *M. gulio* among four fish size groups; the vertical bars indicate the standard error of the mean

In contrast to the gobies fish (Pogoreutz & Ahnelt, 2014), a relationship between RGL and trophic level has been identified (Karachle et al., 2010). This relationship is believed to reflect the time it takes to digest food. Herbivorous fish species, for example, tend to have higher RGL values than omnivorous and carnivorous fish because fibrous plant material takes longer to digest. Although RGL varies between fish species at each growth stage, German & Horn (2006) categorize fish as carnivorous (RGL = 0.6–0.8), omnivorous (RGL = 0.8–1.0), or herbivorous (RGL = 2.5–16.4). Sangma et al. (2019) stated that there was no significant difference in the relative gut length index of fish based on their development (young and adult fish), and this indicated that growth did not involve a shift in fish habits in the carnivorous fish of *Channda nama* and *Trichogaster latius.*

CONCLUSION

Taken together it can be concluded that the food composition of *Mystus gulio* is insects, crustaceans, mollusks, fish, detritus, and algae. Based on the observed RGL values, the feeding habits of *M. gulio* are revealed as omnivorous to carnivorous. The feeding intensity was highest in November, at Cidamar estuaries and in the second size group.

Supplementary Materials: no supplementary materials

AUTHOR CONTRIBUTION

E.P. study concept, design, and intellectual content; acquisition of data; analysis and interpretation of data; drafting and writing of the manuscript, Y.D. discussion and critical revision of the manuscript, T.H. critical revision of the manuscript, acquisition of some of the data, I. critical revision of the manuscript, H. critical revision of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

REFERENCES

Abbas, A. (2010). Food and Feeding Habits of Freshwater Catfish, Eutropiichthys vacha Indian. *J, Sci, Ras,* 1(2), 81–86.

Arockraraj, A, J., Haniffa, M, A., Seetharaman, S. & Singh, S. P. (2004). Indices and Fecundity of Threatened Freshwater Catfish Mystus montanus. *J, Indian Fish, Assoc*, 31, 87–96. Retrived from http://hdl.handle,net/1834/32992.

Arechavala-Lopez, P., Cabrera-Álvarez, M. J., Maia, C. M., Saraiva, J. L. (2022). Environmental Enrichment in Fish Aquaculture: A Review of Fundamental and Practical Aspects. *Rev, Aquac*, 14(2), 704–728. DOI: 10.1111/raq.12620.

Bhakta, D., Das, S. K., Das, B. K., Nagesh, T. S. & Behera, S. (2019). Food and Feeding Habits of *Otolithoides pama* (Hamilton, 1822) Occurring from Hooghly-Matlah Estuary of West Bengal, India. *Regional Studies in Marine Science*, 32, 100860. DOI: 10.1016/j.rsma.2019.100860.

Chan, Y. J., Mei-Fong, C. & Chung-Lim, L. (2013). Optimization of Palm Oil Mill Effluent Treatment in An Integrated Anaerobic-Aerobic Bioreactor. *Sustainable Environment Research*, 23,(3), 153–170.

Chen, X., Liu, B. (2022), Biology of Fishery Resources. Retrived from https://link.springer.com/book/10.1007/978-981-16-6948-4.

Chipps, S. R. & Garvey, J. E. (2007). Assessment of Food Habits and Feeding Patterns. Analysis and Interpretation of Freshwater Fisheries Data. American Fisheries Society. Retrived from https://fisheries.org/doi/9781888569773-ch11/.

Dinh, M. Q., Tran, T. L. & Nguyen, T. K. T. (2018), The Relative Gut Length and Gastro-Somatic Indices of The Mudskipper Periophthal-Modon Septemradiatus (Hamilton, 1822) from The Hau River. *VNU J, Sci, Nat, Sci, Technol,* 34(3). DOI: 10.25073/2588-1140/vnunst,4775.

Dinh, Q. M., Truong, N. T., Nguyen, T. H. D., Lam, T. T. H., Nguyen, T. T. K., Le, D. Q. & Das, S. K. (2022), Feeding Ecology of *Ellochelon vaigiensis* (Quoy & Gaimard, 1825) Living in The Mekong Delta, Vietnam. Ecology and Evolution, 12(9), e9352.

German, D, P. & Horn, M, H. (2006). Gut Length And Mass in Herbivorous and Carnivorous Prickleback Fishes (Teleostei: Stichaeidae): Ontogenetic, Dietary, and Phylogenetic Effects. *Marine Biology,* 148, 1123–1134. DOI:

org/10.1007/s00227-005-0149-4.

Gupta, S. (2014). Morphology, Growth Pattern, Feeding and Reproductive Biology of *Mystus gulio* (Hamilton-Buchanan, 1822) (Siluriformes: Bagridae), *International Journal of Aquatic Biology*, 2(4), 201–205. DOI: 10.22034/ijab.v2i4.86.

Hilker, F. M., Lewis, M. A. (2010). Predator–Prey Systems in Streams and Rivers, *Theoretical Ecology*, 3, 175–193. DOI: 10.1007/s12080-009-0062-4.

Hossain, A. M. & Dutta, H. M. (2017). Phylogeny, Ontogeny, Structure and Function of Digestive Tract Appendages (Caeca) in Teleost Fish. *Fish Morphology*, 59-76.

Hossain, M. Y., Islam, R., Hossen, M. A., Rahman, O., Hossain, M. A., Islam, M. A. & Alam, M. J. (2015). Threatened Fishes of The World: *Mystus gulio* (Hamilton, 1822) (Siluriformes: Bagridae), Ribar. *Croatian Journal of Fisheries*, 73(1), 43–45. DOI: 10.14798/73.1.792.

Karachle, P. K. & Stergiou, K. I. (2010), Gut Length for Several Marine Fish: Relationships with Body Length and Trophic Implications. *Marine Biodiversity*, 3(e106). DOI: 10.1017/S1755267210000904.

Kottelat, M. & Whitten, T. (1996). *Freshwater Fishes of Western Indonesia and Sulawesi: Additions and Corrections*. Hongkong: Periplus editions.

Kumar, P., Biswas, G., Ghoshal, T. K., Kailasam, M., Christina, L., Vijayan, K. K. (2019). Current Knowledge on The Biology, Captive Breeding and Aquaculture of The Brackishwater Catfish, *Mystus gulio* (Hamilton, 1822): A Review. *Aquaculture*, 499, 243–250. DOI: 10.1016/j.aquaculture.2018.09.045.

Kurbah, B. M., Bhuyan, R. N. (2018). Analysis of Feeding Behaviour and Gastro-Somatic Index (GaSI) During Different Phases of Breeding Cycle of *Monopterus cuchia* (Hamilton, 1822) from Meghalaya, India. *Journal of Applied and Natural Science*, 10(4), 1187–1191. DOI: 10.31018/jans.v10i4.1907.

Lall, S. P. & Tibbetts, S. M. (2009). *Nutrition, Feeding, and Behavior of Fish. Veterinary Clinics of North America: Exotic Animal Practice*, 12(2), 361-372. DOI: 10.1016/j.cvex.2009.01.005.

Lanthaimeilu, K. & Bhattacharjee, P. (2018). Relative Gut Length and Gastro-Somatic Index of *Pethia conchonius* (Hamilton, 1822) and *Trichogaster fasciata* Bloch & Schneider 1801, Tripura. *Journal of Entomology and Zoology Studies,* 6(2), 2403-2407.

Le Pape, O. & Bonhommeau, S. (2015). The Food Limitation Hypothesis for Juvenile Marine Fish. *Fish and Fisheries*, 16(3), 373-398.

Leigh, S. C., Nguyen-Phuc, B. Q. & German, D. P. (2018). The Effects of Protein and Fiber Content on Gut Structure and Function in Zebrafish (*Danio rerio*). *J. Comp Physiol B*, B, 188(237–253). DOI: 10.1007/s00360-017-1122-5.

Menon, M,D. (1950). Bionomics of The Poor-cod (*Gadus minutus* L.) in The Plymouth Area. Journal of the Marine Biological Association of the United Kingdom, 29(1), 185–239.

Mingist, M., Dessie, A., Mequanent, D. & Aemro, D. (2023). Food and Feeding Habits of *Labeobarbus intermedius* in The Recently Built Ribb Reservoir, Northwest Ethiopia. *Fisheries and Aquatic Sciences*, 26(8), 482-490.

Mitu, N. R. & Alam, M. M. (2016). Feeding Ecology of a Bagrid Catfish, *Mystus tengara* (Hamilton, 1822) in The Tanore Wetland of Rajshahi, Northwestern Bangladesh. *Journal Applied Ichthyology*, 32(3), 448–455. DOI: 10.1111/jai.13049.

Moyle, P. B. & Cech, J. J. (2000). *Fishes: an Introduction to Ichthyology* (4th Edition). Retrived from https://www.amazon.com/Fishes-Introduction-Ichthyology-Peter-Moyle/dp/0130112828.

Nanjo, K., Kohno, H. & Sano, M. (2008). Food Habits of Fishes in The Mangrove Estuary of Urauchi River, Iriomote Island, Southern Japan. *Fish Science*, 74, 1024–1033. DOI: 10.1111/j.1444-2906.2008.01620.x.

Paujiah, E., Solihin, D. D. & Affandi, R. (2019), Community Structure of Fish and Environmental Characteristics in Cisadea river, West Java, Indonesia. *Jurnal Biodjati*, 4(2), 278–290. DOI: 10.15575/biodjati.v4i2,6096.

Pogoreutz, C. & Ahnelt, H. (2014), Gut Morphology And Relative Gut Length do Not Reliably Reflect Trophic Level in Gobiids: A Compar-Ison of Four Species From A Tropical Indo-Pacific Seagrass Bed. *Journal Applied Ichthyology,* 30(2), 408–410. DOI: 10.1111/jai.12295.

Rathod, S. D. (2023). Feeding Habit and Pollution Indicating Food Items of *Mystus gulio* (Hamilton, 1822) in The Inward Waters of Mumbai Coast, *Mar Pollut Bull*, 190, 114876. DOI: 10.1016/j.marpolbul.2023.11487.

Richardson, G., Dickinson, P., Burman, O. H. P. & Pike, T. W. (2018). Unpredictable Movement as An Anti-Predator Strategy. *Proc, R, Soc, B*. 285(1885), 20181112. DOI: 10.1098/rspb.2018.1112.

Samad, M. A., Rahman, M. A., Yeasmin, S. M., Rahman, M. H. & Hossain, M. Y. (2023). Assessment of Stock Status, Metal Contents with Human Health Risk of Gudusia chapra from Oxbow lake, Bangladesh. *Heliyon,* 9(4).

Sangma, S. K., Bhattacharjee, P. & Pal, P. (2019). Length-Weight Relationship, Relative Length of Gut and Gastro-Somatic Index of *Chanda nama* (Hamilton, 1822) and *Trichogaster lalius* (Hamilton, 1822) from Tripura, India. *Journal of Entomology and Zoology Studies*, 7(3), 737–742.

Thomas, S. M. Chadha, N. K., Purayil, S. B., Kandiyil, A. P., Kavungal, V., Joseph, I. & Abhijith, R. (2018). The Food and Feeding Habits of Goldsilk Seabream, Acantho pagrusberda (Forsskal, 1775). *Turk. J. Fish.& Aquat. Sci.* 19(7), 605-614. DOI: 10.4194/1303-2712-v19_7_07.

Suryandari, A. & Tjahjo, D,W,H. (2013), Hubungan Panjang Berat, Makanan, dan Sebaran Ikan Kating, *Mystus gulio* (Hamilton 1822) di Segara Anakan, Cilacap. *Prosiding Seminar Nasional Ikan* 8, 41–47.

Talwar, P. K. & Jhingran, A. G. (1991). *Inland Fishes of India and Adjacent Countries (Volume 2).* CRC Press.

Vieux, F., Perignon, M., Gazan, R., Darmon, N. (2018). Dietary Changes Needed to Improve Diet Sustainability: are they Similar Across Europe?. *Eur. J. Clin, Nutr*. 72(7), 951–960. DOI: 10.1038/s41430-017-0080-z.

Villéger, S., Brosse, S., Mouchet, M., Mouillot, D. & Vanni, M, J, S. (2017). Functional Ecology of Fish: Current Approaches and Future Challenges. *Aquat, Sci*, 79, 783–801. DOI: 10.1007/s00027-017-0546-z.

Vo, L. T. T., Tran, A. N., Phan, T. Q. & Dinh, Q. M. L. (2023), The Reproductive Biology of Mystus mysticetus Robert, 1992 in The Mekong Delta, Vietnam. *Egypt, J, Aquat, Res*, 49(1), 105–112.

DOI: 10.1016/j.ejar.2022.05.002.

Weliange, W. S. & Amarasinghe, U. S. (2007). Relationship Between Body Shape and Food Habits of Fish From Three Reservoirs of Sri Lanka, Asian Fish, Sci, 20 (3/4), 257. Retrived from sianfisheries-society,org.

Zuliani, Z., Muchlisin, Z. A. & Nurfadillah, N. (2016). Kebiasaan Makanan dan Hubungan Panjang Berat Ikan Julung-julung (*Dermogenys* sp.) di Sungai Alur Hitam Kecamatan Bendahara Kabupaten Aceh Tamiang. *Dissertation*,. Aceh: Syiah Kuala University.